SPECIALTY RESIN CLEANERS

METHODS FOR CLEANING ION EXCHANGE RESINS

SYBRON CHEMICALS INC.

IRON FOULING

ORGANIC FOULING

OIL FOULING

MUD FOULING

ALGAE & BACTERIA FOULING

AND MUCH MORE...

SYBRON CHEMICALS INC. BIRMINGHAM, NEW JERSEY 08011
(609) 893-1100 (800) 678-0020 FAX: (609) 894-8641 URL: www.ionexchange.com

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SYBRON CHEMICALS INC.
Birmingham Road
Birmingham, New Jersey 08011

(800) 678-0020
(609) 893-1100
(609) 894-8641 FAX
www.ionexchange.com

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SYBRON CHEMICALS INC. has earned worldwide acceptance as a manufacturer of quality products with in-house technical expertise and a commitment to customer service.

The company's **Environmental Products Group** supplies the following water treatment products and biochemicals to the water and wastewater industry:

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SYBRON CHEMICAL INC. BIRMINGHAM, NEW JERSEY 08011
TELE: (609) 893-1100 1-800-678-0020 FAX: (609) 894-8641

ABSTRACT

This paper was developed to provide the engineer or operating personnel responsible for daily operation and maintenance of industrial ion exchange plants a more complete understanding of the types of contaminants and agents responsible for the deterioration and fouling of ion exchange resins. Also included are various cleaning procedures presently being used today to extend the life of ion exchange resins, operating under less than ideal conditions, and to improve their overall performance.

Ion exchange resins have been used to treat and improve the quality of water throughout the world for well over 50 years. Not only are ion exchange resins used to improve the quality of potable waters, which effects our daily lives, but their use is critical in the development of new technologies, such as the nuclear power and semiconductor industries, where high purity water is an essential part of the process.

During the ion exchange process, resins may be exposed to a variety of substances that can act as foulants, oxidizing agents or even catalysts, which can reduce operating efficiency and shorten the useful life of the resin. The source of these contaminants may be from the water being treated (source dependent), or from poor quality regenerants improperly stored in metal bulk storage containers. Other examples include air-born contaminates, possibly from a degasifer located in an area where high levels of dust, microorganisms or other foreign matter can easily contaminate a water supply, or precipitates formed from poorly executed regeneration procedures that can irreversibly foul an ion exchange resin... All of these contaminants, no matter what the source, can contribute to poor resin performance.

In some instances, the ion exchange resins become so fouled or deteriorated that replacement with new media is the only answer. Often, however, the ion exchange resin may only require cleaning, using the proper cleaning procedure, to restore most of its original capacity.

In most cases, cleaning the ion exchange is much less costly than replacement with new resin, however, it would be foolish and a waste of resources to try to clean an ion exchange resin which is irreversibly fouled or chemically and physically impaired.

To minimize this type of error, normally, the first step in any resin cleaning program is to have representative resin samples taken for routine laboratory analysis (*resin sampling techniques will be discussed later in this paper, see page C.*).

The resin samples should be tested for moisture content for both cation and anion resins, total cation capacity and total/salt-splitting capacity for anion resins. These results will then be compared against values for new resins to determine the condition of the ion exchange resin. (*See pages D. and E. for more detailed information.*)

Additional testing for resin foulants can also be conducted via the laboratory. Normally, cation resins are tested for iron and possibly aluminum fouling, while anion resins are tested for organic fouling and possible iron fouling on request. Whole bead count is another test which can be conducted to help determine the physical condition of the resin beads. In most instances, a well developed resin testing laboratory, will not only be able to suggest the best possible cleaning procedure, but also determine its effectiveness.

In addition to laboratory testing, many times, simple field tests can also be performed on representative resin samples to confirm the nature of the suspected fouling agent. Some of these simple and quick field tests will be described in detail under the appropriate sections.

Other contaminants and agents that will have an effect on the performance of the ion exchange resin and the quality of the treated water include biological matter and oxidizing agents, such as chlorine and ozone, which require their own special methods of treatment.

The identification of resin foulants and related cleaning procedures can, at times, be an expensive, time consuming affair. Once all of the field and laboratory data has been collected and evaluated, a final decision must be made as to whether resin cleaning or resin replacement is the most cost effective approach. The age of the resin, the amount of resin, equipment downtime, and chemical/man power costs are additional factors that should be consider when making the final decision.

Hopefully, this presentation will provide some insight into the types of foulants/agents affecting ion exchange resins, along with associated cleaning procedures, and descriptions of various laboratory and field tests.

The final decision is yours as to whether replacement or cleaning of the affected resin is the most cost effective approach - make sure its the right choice!

RESIN CLEANING - SUSPENDED SOLIDS

SUSPENDED SOLIDS: Although ion exchange resins are used extensively to remove unwanted *dissolved solids* from water supplies, in many instances, the ion exchange media also serves as a filter for suspended solids removal. Turbidity and sediment not thoroughly removed from the water supply prior to entering lead ion exchange units can accumulate in the resin bed resulting in high pressure drop and poor performance due to hydraulic channeling.

Generally, the dirt and debris collected by the ion exchange media consists of inorganic materials such as mud, silica, silt, clay or corrosion products, while organic materials such as finely divided vegetable and animal matter, algae, microorganisms, oils and fats can also contribute to the suspended solids loading on the ion exchange resin bed.

Although conventional downflow ion exchange units can tolerate some degree of suspended solids loading, when proper backwash techniques are used, ion exchange resins are not designed or intended for this purpose. The new *packed bed* DI systems, which by design, have no true freeboard, are much more sensitive to high suspended solids levels and are limited to less than 1 ppm in the influent water supply.

Using proper backwash techniques, as specified by the equipment manufacturer, does not always guarantee satisfactory results. The suspended solids level may simply be too high for standard backwash techniques to be effective, and require a more rigorous backwash schedule. The material being filtered by the ion exchange media may be of such a nature that it adheres to the resin beads and is not easily removed, or in some instances the density of the filtered material may be higher than the density of the resin beads, making solids removal difficult if not impossible.

Under extreme conditions, suspended solids accumulate on the resin bed forming a filter cake resulting in excessive pressure drop and poor distribution of both regenerant and service water.

To help protect ion exchange systems from these types of complications, a turbidity limit of 5 ppm, ALPHA standards have been placed on influent waters to be treated with standard cocurrent ion exchange systems. Where this limit is exceeded, suspended solids removal by clarification and/or coagulation/filtration is recommended.

If pretreatment is not being utilized or not working properly, and turbidity and sediment are identified as the cause of fouling of the resin bed, the following procedures should be employed;

*** See product bulletins for detailed information**

****

SUSPENDED SOLIDS REMOVAL
(SOFTENERS - CATION UNITS)

PROCEDURES: Prior to any chemical treatment, the resin bed should be backwashed for at least one to two hours at a backwash flow rate that expands the resin bed a minimum of 65-70%. The flow rate should be controlled manually via the backwash outlet valve. If ion exchange vessels are not equipped with sight glasses, samples of the backwash water should be taken at regular intervals to ensure that ion exchange resin (whole beads) is not being lost.

If the extended backwash procedure does not produce acceptable results, chemical treatment of the resin may become necessary. **Sybron Chemical Inc.** presently offers two cleaning products, **Sybron SRC-1010*** and **SRC-7400***. Both products, when used together, have been shown to be quite effective in the removal of silt, clay, organic matter and suspended matter from ion exchange resins. Other **SYBRON** products which are especially effective against precipitates, metals or suspended solids that form a hard, tenacious coating around the resin beads are **SRC-3011*, SRC-2011*** and **SRC-5000*** for aluminum and magnesium hydroxide fouling.

To remove suspended materials from the resin bed, the following procedure should be employed.

1. Regenerate the resin bed with sodium chloride, using 15 lbs. sodium chloride per cubic of resin and rinsed.

2. Backwash the resin bed using the technique shown in the first procedure until the effluent runs clear.

3. The manway cover should be removed and the unit drained to approximately 4-6 inches above the resin bed.

4. Add enough Sybron SRC-1011* or SRC-7400* to produce a <1% solution in the unit. (1 gallon to 35-70 gallons softened water) *** Sybron **SRC-7400** may be added along with the **SRC-1010** at a <1% concentration when oil or organic material is part of the fouling problem.*

5. The cleaning agent should be added through the top manway while air agitation is applied via an air lance to ensure good mixing. (See page B., air lance)

6. Air mixing should continue for several hours, leaving the solution to set over night if possible.

7. At the end of the soaking period, the unit should be filled with water to within 20-30 inches of the manway and air mixed for an additional 1-2 hours if required. The resin bed is then backwashed, preferably through an open manway, for 1-2 hours or until the backwash water is clean and clear. The backwash rate must be carefully controlled to avoid excessive resin loss.

8. After the backwash is completed, the manway should be replaced and the resin bed rinsed until any foam disappears.

9. The resin bed is then double or triple regenerated to convert the exchange sites to their desired form--rinse, and return to service

The data included herein are based on test information obtained by Sybron Chemicals Inc. These data are believed to be reliable but do not imply any warranty or performance guarantee. We recommend that the user determine performance by testing on his own processing equipment. We assume no liability or responsibility for patent infringement resulting from the use of this product.

RESIN CLEANING - IRON AND MANGANESE

IRON: Almost all water supplies contain iron. When the level iron in the water supply exceeds 0.3 ppm, the iron can become noticeable as a brown-red color in the water supply. As to whether the iron becomes a problem to the ion exchange process will depend not only on its concentration, but also on the type of iron and other contaminants or agents existing in the water supply. Iron can exist in various forms in water supplies, which makes it difficult to provide one all inclusive solution to its removal.

Iron can occur in water supplies in several forms and can be categorized as follows:

1. Suspended Insoluble Iron
2. Ferric Hydroxide (Red Water Iron)
3. Soluble Ferrous Bicarbonate (Clear Water Iron)
4. Organic Iron Complexes (Heme-Iron)
5. Sequestered Iron
6. Bacterial Iron (Also See Sulfur)

Suspended iron can be removed by the filtering action of the ion exchange unit down to approximately 40 microns. Suspended iron in the form of a colloidal (finely divided) suspension may pass through the ion exchange unit unimpeded. Fine filtration (5-25 micron) will usually remove colloidal type iron. Vigorous backwashing prior to regeneration is the most effective method of preventing the accumulation of iron in the resin bed. A 65% to 70% bed expansion with an extended backwash cycle is recommended.

Another form of iron which is frequently found in well water that has come in contact with air prior to ion exchange treatment is ferric hydroxide or red water iron. Ferric hydroxide is by nature a very gelatinous precipitate which can coat the resin beads causing a drastic reduction in capacity. This type of iron is not easily removed by simple backwashing and requires the use of chemical cleaners such as reducing agents, sequestering agents or for industrial applications, the use of strong mineral acids, which are effective against most types of iron.

One type of iron which has the potential to cause a troublesome situation with resin fouling is soluble ferrous iron, or clear water iron. Although this type of iron (Fe^{++}) is easily removed from a water supply by a standard softening resin and subsequently removed from the resin along with the hardness via a standard brine regeneration, iron fouling of the resin can occur when the ferrous (Fe^{++}) form of the iron is oxidized to the insoluble ferric form (Fe^{+++}) by dissolved oxygen or chlorine in the water supply.

When this process occurs in the resin bed, the soluble ferrous is converted to the insoluble ferric oxide form within the resin bead structure and with repeated cycles of operation can completely foul the resin bed. Since most natural water supplies contain some level of iron, fouling will occur to some degree on all cation exchange resins. How troublesome the iron fouling becomes will not only depend on the type and level of iron in the water, but will also depend on other factors such as pH, hardness, TDS, dissolved oxygen, chlorine content and type of regenerant. With iron bearing waters containing iron levels over 10 ppm iron, a resin cleaner should be used on softening resins three to four times per year to prevent iron fouling. Weekly or monthly use of resin cleaner may be required for some waters. Since this type of iron precipitation not only adheres to the resin bead surface, but also permeates into the pores of the resin beads, its removal is quite difficult. For industrial softeners or demineralizer systems the most effective method for the removal of this type of iron precipitate is the use of strong mineral acids, provided that the internal construction of the ion exchange units and associated piping is compatible. For domestic, small commercial softeners or industrial ion exchange systems, where standard, strong mineral acids can not be tolerated, speciality cleaning products such as **Sybron SRC-2011*** and **SRC-3011*** have been developed to provide relatively safe, effective alternatives. Both of these multicomponent products not only have the ability to remove iron and manganese form the softening resin, but also have the ability to sequester precipitated hardness including barium.

Another category of iron which is usually detected on anion resins is Heme-Iron (organic iron complexes) which is sometimes present in water from shallow wells or surface water supplies. These large, high molecular weight organic-iron complexes can bond at several sites within the *anion* resin matrix and are resistant to removal during the normal regeneration process. The most successful method of removing this type of iron complex from anion resin is to treat the anion resin with a 6% solution of Sybron **SRC-3014*** immediately following the alkaline cleaning procedure used for organic removal. The anion resin must be in the chloride form prior to the **SRC-3014*** addition, and soak and displacement should take place over a two hour period.

For household or small commercial softener units, where strong mineral acids cannot be used, speciality cleaning solutions such as **Sybron SRC-3010*** or **SRC-3011*** may be substituted

Although resin testing by a qualified resin laboratory is the most reliable method of determining the condition of a resin, the following qualitative field test can be performed on site to provide a quick determination of iron fouling.

*** See product bulletins for detailed information**

RESIN CLEANING - IRON AND MANGANESE

****

FIELD TEST FOR IRON ON RESIN
(CATION)

PROCEDURE: The following field test for iron fouling of either cation resin or anion resin must be performed on freshly regenerated resin to differentiate between iron that would normally be removed during a standard regeneration and iron that would require additional cleaning to be removed.

1. Measure into a 200 ml pyrex beaker approximately 50 mls of softened or demineralized water along with 50 mls of water white HCl.

2. Add approximately 50-75 mls of suspected resin.

3. Heat to almost boiling and stir for 15-20 minutes

4. Remove from heat and read color of solution as follows:

A. Light Straw Color - Trace of iron

B. Light Beer Color - moderate iron fouling

C. Dark Tea Color - heavy iron fouling

5. To ensure that the color of the above solution is not the result of certain organic contaminants, rather than iron, the following steps should be added.

6. Pour approximately 30 mls of colored liquid from previous test to another beaker and dilute with tap water to 150-200 ml mark.

7. Add a small amount of potassium thiocyanate and gently stir.

8. Read the resulting color due to iron as follows:

A. No Color Change - orginal color due to organics

B. Red-Purple Color - orginal color due to iron

9. The more intense the color the greater the amount of iron.

*Note: *As with any acid, extreme caution must be observed when handling hydrochloric acid.*

Iron can also be associated with microorganisms or bacterial iron. Bacterial iron is actually a microorganism that utilizes ferrous bicarbonate in its metabolic process. As part of the bacterial metabolic process iron is precipitated to its insoluble state and deposited around the cell wall. Crenothrix, Clonothrix and Gallionella are common types of iron bacteria and live in a wide range of environmental conditions. Water containing this type of iron will have a light red color and may have an objectionable odor. Generally, bactericides are effective in treating this type of iron. (*Also see filamentous sulfur bacteria under "sulfur"*)

The last category of iron which is frequently encountered in municipal treated waters is sequestered iron. Some municipalities, as a standard practice, will feed sequestering agents such as sodium tripolyphosphate, hexametaphosphate or sodium silicate to inhibit corrosion and to "tie-up" metal ions such as iron. These additives prevent iron from precipitating and causing the characteristic red stain common to iron bearing water.

These sequestering agents will inhibit the exchange of iron on to cation exchange resins (softeners and cation D.I.) and may pass through the softening or cation unit unaffected. Unfortunately, once the water has reached a hot water heater or boiler, the complex can be broken down by heat resulting in iron precipitation.

Generally, polyphosphates are fed into the water at a two to one (phosphate:iron) ratio with 4 ppm as a minimum level. However in many instances, the polyphosphate is under fed with only a portion of the iron being sequestered.

Laboratory testing at Sybron Chemicals Inc., using a standard mixed bed resin, indicates that the iron-phosphate complex can be removed by a strong base anion resin. These tests also indicated that although the iron-phosphate complex was easily removed from the resin with caustic regeneration, the capacity of the anion resin was greatly reduced during the service cycle.

Symptoms of iron fouling for most softeners or demineralizer systems may be seen as an increase in the effluent level of iron, reduction in operating capacity, or possibly a reduction in backwash efficiency under identical operating conditions. In severe cases, the effluent iron will exceed the influent iron resulting in "red water".

Over the years various methods have been developed or used to clean iron fouled resins. In general, the cleaning procedure most suited to a particular system will depend on the type of iron fouling, compatibility of equipment to the cleaning agent and the knowledge and experience of the personnel responsible for the resin cleaning.

Cleaning agents used in the removal of iron from resin beds can be broken down into three broad categories which include; reducing agents, sequestering agents and acid cleaners (weak and strong) -- all having some degree of success.

Later, speciality cleaners were developed which enhanced the cleaning properties of these basic cleaners through the addition of specially formulated salts, surfactants and inhibitors.

RESIN CLEANING - IRON AND MANGANESE

Reducing agents, such as sodium bisulfite or sodium hydrosulfite, used as cleaning agents, will normally remove surface iron only. The agents react with the ferric iron to give a ferrous salt which is much easier to remove from the resin bed than the gelatinous ferric hydroxide. Reducing agents can be combined with various sequestering and dispersing agents to improve their overall ability to remove insoluble iron, along with other dirt and debris, and to prevent additional precipitation during the cleaning process. These speciality resin cleaners have been found to be much more effective than basic resin cleaners, especially when other contaminants are present on the resin.

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SYBRON SRC-2011

(IRON CLEANING - SOFTENERS)

Commercial and light industrial

PROCEDURE: Prior to any chemical cleaning treatment, the resin bed should be regenerated with NaCl and backwashed for at least one to two hours or until backwash water is clear at a backwash flow rate that expands the resin bed at least 65-70%.

The backwash flow rate should be controlled manually via the backwash outlet valve. If the ion exchange vessels are not equipped with sight glasses, samples of the backwash water should be taken at regular intervals and checked for suspended iron, dirt, resin fines or resin beads. If whole resin beads are found in the backwash samples, the backwash flow should be reduced.

As discussed in a previous section, sequestering agents and dispersants can be used in combination with cleaning agents to improve the overall efficiency of the cleaning process. Not only does the sequestering agent solubilize iron, dirt and debris, it has been found to be quite effective in stabilizing the cleaning solution and extending its iron removing capabilities. **SYBRON SRC-2011*** combines all these qualities into one resin cleaner.

1. Regenerate the resin with sodium chloride, using 15-20 lbs. of sodium chloride per cubic foot of resin at 10% concentration

2. Backwash the resin for 1-2 hours with a minimum of 65% to 70% expansion with softened water.

3. The water level in the softening unit should be drained, from the bottom of the vessel, to within a few inches of the top of the bed.

4. Prepare a solution containing < 5% SRC-2011* (1 lb. in 10 gallons water) using softened water. The quantity of solution should be enough to completely immerse the resin bed in the solution (1 lb. SRC-2011/cu.ft. resin). *Heavily fouled resins may require a solution strength of 8% - 10%*

Continued ...

5. The cleaning agent should be added through the top manway while air agitation is applied via an air lance to ensure good mixing. (See page B) It may be necessary to drain the existing water from the bottom of the resin bed to ensure that the resin is completely immersed in the cleaning solution.

6. Using an inert gas (nitrogen) completely mix resin bed for 45 to 90 minutes using an air lance (See page B.). If nitrogen is not available, air can be used, but the mixing time should be limited to 15-20 minutes.

7. The solution should be allowed to remain in contact with the resin for a minimum of 6 hours or over night if possible.

8. After the contact period, the resin bed should be air mixed a second time for 15 to 20 minutes.

9. After final mixing, the unit should be filled with water to within 20-30 inches of the manway and backwashed preferably through the open manway for 1-2 hours or until the backwash water is clean and clear. The backwash rate must be carefully controlled to avoid excessive resin loss.

10. After the backwash is completed, the manway should be replaced, the unit repressurized, and the resin bed rinsed until any foam disappears.

11. The resin bed is then double regenerated to convert the exchange sites to the desired form.

12. The unit is rinsed and returned to service.

SYBRON SRC-2011* is a resin cleaner formulated specifically for use in cleaning softening resins subjected to iron-manganese fouling, precipitated hardness and general crud from the surface of the resin bead.

SYBRON SRC-2011* is a blend of solubilizing agents, sequestering agents and dispersants designed to remove precipitated inorganic foulants from the resin bead without damage to softening equipment.

For heavily fouled resins, **SRC-2011*** should always be used in conjunction with an air lance which ensures good contact between the resin and the cleaning compound.

SYBRON SRC-2011* is particularly well suited for periodic cleaning of the softening resin by adding a concentrated solution to the brine well prior to brine regeneration.

Note: SYBRON SRC-2011 should only be used on softening resins according to product instructions. When handling, using or storing this material adequate ventilation must be provided. Consult product bulletins and MSDS data sheet before handling.

*** See product bulletins for additional information**

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RESIN CLEANING - IRON AND MANGANESE

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SYBRON SRC-2011

(IRON CLEANING - SOFTENERS - ALTERNATE METHOD)

Commercial and light industrial

PROCEDURE: This procedure can be used as an alternate to the above procedure. In general, this procedure is not as time consuming and is normally used on softening resins which are lightly fouled with surface iron and crud(1-2 grams/ cubic foot of iron).

1. For softening units, regenerate the resin bed with sodium chloride, using 15-20 lbs. of sodium chloride per cubic of resin. Rinse water from the resin bed using soft water.

2. Drain the water from the unit to a level of approximately 4-6 inches above the resin bed.

3. Add 1 pound of SRC-2011* per cubic of resin through an open manway while avoiding fumes.

4. Air lance to obtain good mixing and continue for two hours using inert gas (nitrogen) or 15-20 minutes with air, followed by 2 hour soak.

5. Re-pressurize unit and rinse with 2-3 bed volumes of softened water and backwash resin bed until water runs clear.

6. Double regenerate and return to service.

SYBRON SRC-2011* is supplied in 40 pound containers and is completely soluble in water.

Material Safety Sheets containing detailed information on **SRC-2011*** are available on request.

SRC-2011* is most effective when used in conjunction with an air lance and an oil free, inert gas such as nitrogen.

SYBRON SRC-2011* is particularly well suited for periodic cleaning of the softening resin by adding a concentrated solution to the brine well prior to brine regeneration.

Note: SYBRON SRC-2011 should only be used on softening resins according to product instructions. When handling, using or storing this material adequate ventilation must be provided. Consult product bulletins and MSDS data sheet before handling.

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SYBRON SRC-3011

(IRON CLEANING - SOFTENERS)

Commercial and light industrial

PROCEDURE: This general procedure for iron removal can be used where iron fouling is moderate to heavy, but not limited to surface fouling. Although most resin cleaners are not as aggressive as hydrochloric acid in removing precipitated iron from the resin pores, **Sybron SRC-3011*** will remove precipitated iron from below the surface of the resin bead and has the advantage of not being as difficult to use as hydrochloric acid.

1. Prior to any cleaning procedure the resin should undergo an extended backwash to ensure that all suspended matter is removed.

2. The resin should then be regenerated with 15 to 20 lbs. of salt per cubic foot of resin to prevent any precipitates from forming. Rinse the brine from the resin bed using soft water.

3. Prepare 3-4 bed volumes of solution containing approximately 2.5%-5% (1 gallon in 35 gallons of water) SRC-3011*in softened or DI water. Always add chemical to water, and prepare solution in well ventilated area to avoid inhalation of noxious fumes. *Note: For heavily fouled resins an 8%-10% concentrated solution may be required.*

4. Introduce the solution to the softening unit at a flow rate of ~ 0.25 gpm/cu.ft. The second or third bed volume of cleaning solution should be retained in the resin bed (soaking period) for 3-5 hours. Heating of the cleaning solution to 95-100 ^{O}F prior to its use improves its cleaning efficiency.

5. After passing the last bed volume of cleaning solution through the resin bed, the softener unit should be rinsed with 3-5 bed volumes of softened water and backwashed for 30-60 minutes.

6. The resin bed is then double regenerated using a 10% brine solution and rinsed prior to service.

Note: SYBRON SRC-3011 should only be used on softening resins according to product instructions. When handling, using or storing this material adequate ventilation must be provided. Consult product bulletins and MSDS data sheet before handling.

*** See product bulletins for detailed information**

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SYBRON SRC-3011

(IRON CLEANING - SOFTENERS - ALTERNATE)

Commercial and light industrial

PROCEDURE: This procedure can be used as an alternate to the general procedure for iron removal. For smaller units this procedure is the most efficient and effective method of utilizing chemicals and manpower. As with any cleaning solution, unit materials of construction must be taken into consideration from an chemical resistance standpoint.

1. Prior to any cleaning procedure the resin should undergo an extended backwash to ensure that all suspended matter is removed.

2. The resin should then be regenerated with 15 to 20 lbs. Of salt per cubic foot of resin to prevent any precipitates from forming. Rinse the brine from the resin bed using soft water.

3. Drain the water from the unit to a level of approximately 3-6 inches above the resin bed.

4. Prepare a concentrated solution (2.5%-5%) of SRC-3011* by adding 1 gallon of product per 35 gallons of softened water. The quantity of solution should be enough to completely immerse the resin in solution.

5. Always add chemical to water and prepare solution in adequate ventilation to avoid inhalation of noxious fumes.

6. Add concentrated solution through any convenient opening to the water above resin bed.

7. Air lance resin bed for 1-2 hours to provide good mixing of cleaning solution throughout the resin bed.

8. Let the resin remain in contact with the cleaning solution for 3-4 hours or over night if possible.

9. Rinse cleaning solution from softening unit using 3-5 bed volumes of softened water and backwash at 60%-65% expansion for 1-2 hours.

10. Double regenerate using salt prior to service.

SYBRON SRC-3011* is a "*Fast Acting*" resin cleaner developed specifically for use in cleaning softening resins subjected to higher levels of iron, maganese and general crud.

SRC-3011* is a multicomponent cleaning compound containing chelating agents, sequestering agents and dispersants that are safe for use in most softening equipment.

SRC-3011* is supplied in 40 pound container and is completely soluble in water.

SRC-3011* is particularly well suited for periodic cleaning of the softening resin by adding a concentrated solution to the brine well prior to brine regeneration.

*** See product bulletins for detailed information**

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SYBRON SRC-3014

(IRON CLEANING - SOFTENERS & CATION UNITS)

Light and heavy industrial

PROCEDURE: As mentioned earlier, iron can be a major fouling agent to softening systems. Even with the use of a strong acid such as sulfuric acid to regenerate the lead cation unit in a demineralizer system some accumulation of iron on the resin can take place thereby reducing the performance of the cation resin.

Hydrochloric acid, as a cleaning agent, is most effective in removing all types of iron from all types of resin, however, due to its aggressive nature, special precautions must be taken to avoid damage to equipment. In many instances it may not be possible to treat softening resins or DI systems with hydrochloric acid do to the incompatibility of the acid with internal components and piping. Equipment design must be taken into consideration from an acid resistance standpoint. Before the application of any HCl acid cleaning procedure, material compatibility must be verified.

For some equipment designs **Sybron SRC-3014*** may prove to be acceptable, however, the equipment manufacturer should be consulted prior to any use of any strong acid as a cleaning agent. **Sybron SRC-3014*** is a speciality cleaning solution consisting of a strong inhibited acid, and proprietary dispersing agents, which is capable of removing most heavy metals from ion exchange resins.

The standard procedure for the cleaning of iron fouled resins using **SRC-3014*** is as follows:

1. Thoroughly backwash the resin bed to remove all loose dirt and debris.

2. For softening units, regenerate the resin bed with sodium chloride, using 15-20 lbs. of sodium chloride per cubic of resin. Rinse water from the resin bed using soft water. For DI systems, the cation unit should be in the regenerated state.

3. Drain the water from the unit to a level of approximately six inches above the resin bed.

4. Introduce 2-3 bed volumes of a 8%-10% solution of SRC-3014, using softened or DI water,at a flow rate of 0.25 gpm/cu.ft. If possible the solution should be heated to 95^{O}F prior to introduction for better results.

5. For heavily iron fouled resins, the final bed volume of cleaning solution should be retain in the resin bed for a period of 2-3 hours.

6. With *softening units*, the cleaning solution should be completely drained and rinsed using 3-5 bed volumes of softened water, and then backwash for 30-60 minutes. Double regenerate using salt prior to service.

7. For *hydrogen form cation units* drain and rinse using normal rinse down procedures. Backwash for 30-60 minutes to remove loosened crud and regenerate and return to service.

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SYBRON SRC-3014

(IRON CLEANING - SOFTENERS - CATION UNITS - ALTERNATE)

Light and heavy industrial

PROCEDURE: This procedure can be used as an alternate to the general **SRC-3014** cleaning procedure.

Again, for many equipment designs Sybron **SRC-3014** may be acceptable, however, the equipment manufacturer should be consulted prior to the use of any resin cleaning agent.

The alternate procedure for the cleaning of iron fouled resins using **SRC-3014** is as follows:

1. Thoroughly backwash the resin bed to remove all loose dirt and debris.

2. For softening units, regenerate the resin bed with sodium chloride, using 15-20 lbs. of sodium chloride per cubic of resin. Rinse water from the resin bed using soft water. For DI systems, the cation unit should be in the regenerated state.

3. Drain the water from the unit to a level of approximately six inches above the resin bed or to approximately one half the bed volume of resin.

4. Prepare a concentrated cleaning solution of SRC-3014. Sufficient chemical should be used to produce a 10% solution when the concentrate is dispersed and diluted in the water remaining in the ion exchange unit.

5. The concentrated SCR-3014* solution should then be added to the top of the resin bed while avoiding any vapors or fumes.

6. Drain from the bottom of the ion exchange unit an amount of water equal to the void volume (i.e. approximately 50% of the resin volume).

7. The solution should then be agitated to uniformly disperse the concentrated acid throughout the resin bed.

8. Allow the cleaning solution to remain in contact with the resin for at least 5-6 hours or over night if possible.

9. Drain and rinse downflow (3-5 bed volumes), followed by a 30-45 minute backwash to remove any matter or debris removed from the resin during the soak cycle using softened or DI water.

10. Double regenerate and return unit to service.

SYBRON SRC-3014* is an inhibited, strong acid resin cleaner developed to remove most inorganic materials from ion exchange resins while being relatively safe for most demineralizer systems.

For most equipment designs **SRC-3014*** may be acceptable, however, the equipment manufacturer should be consulted prior to using any strong acid cleaner.

MANGANESE: Although manganese is a sister element to iron and can cause black spots or staining in water systems, the chemistry of manganese is somewhat more complex and only a limited understanding of manganese oxidation exists. The most common precipitate that forms from manganous oxidation is MnOOH. The tolerance for manganese in most processes is low, from 0.003 to 0.2 ppm. Higher amounts can cause bad taste and stains. Manganese is not always present with iron. Iron usually predominates in most natural water supplies with manganese occurring less frequently. Manganese is usually more objectionable and harder to remove. The control and removal of manganese is more complicated by factors that range from slow kinetics, numerous oxidation states and various complexes that may be formed with naturally occurring organics.

Both iron and manganese are removed by similar processes and are normally discussed together.

Sodium and hydrogen form cation exchangers will remove dissolved iron and manganous manganese in the same fashion as they remove other cations. Care must be taken to prevent air entrainment into the service water supply when manganese is present, especially under high pH conditions.

As with iron, one the major difficulties associated with the removal of manganese utilizing ion exchange is the possibility of coating and fouling the cation resin with the oxidized form of the metal.

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MANGANESE CLEANING
(SOFTENERS - CATION UNITS)

Normally it is possible to restore much of the capacity of the ion exchange resin by dissolving the precipitated manganese using the cleaning methods as described earlier for the removal of iron. The success of the cleaning procedure will not only depend on the degree of fouling, but also the form of the precipitate. Its location on the resin bead and the cleaning method used.

Note: Cleaning products can cause severe burns and requires special handling and storage procedures. Some products may be corrosive to unprotected steel and may be incompatible with materials of construction utilized in the ion exchange unit. When handling or storing this material adequate ventilation must be provided. Consult product bulletins and MSDS data sheet before handling.

*** See product bulletins for detailed information**

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RESIN CLEANING - ALUMINUM

ALUMINUM: Although aluminum is the most abundant metallic element known, it is seldom seen in any significant levels in naturally occurring water.

Aluminum found in municipal water is normally associated with water treatment plants where aluminum salts are used to reduce turbidity and suspended solids level in the incoming water supply.

Excess aluminum can carry over into the treated water supply as aluminum sulfate or as an aluminum floc (aluminum hydroxide), a gelatinous precipitate which often brings various contaminants along with it, that can coat and foul resin beads. Generally, due to the small amounts added to the water supply, fouling of the ion exchange can accumulate over a long period of time. Regeneration of softening units with salt will not remove the aluminum from the resin bed and under extreme conditions aluminum floc collecting at the top of the resin bed can result in channeling, lost capacity, high pressure drop and poor unit performance.

Several cleaning procedures are available which used high or low pH solutions to solubilize and remove the aluminum from the resin bed. Since aluminum appears to have only one oxidation state (A^{+++}), the use of any reducing agent would prove to be ineffective.

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SYBRON SRC-3010

(ALUMINUM CLEANING - SOFTENERS)

Commercial and light industrial

1. Prior to any cleaning procedure the resin should undergo an extended backwash to ensure that all suspended matter is removed.

2. The resin should then be regenerated with 15 to 20 lbs. of salt per cubic foot of resin to prevent any precipitates from forming. Rinse the brine from the resin bed using soft water.

3. Prepare three to four bed volumes of solution containing approximately 5%-10% Sybron SRC-3010*. Always add chemical to softened or DI waterwater, and prepare solution in well ventilated area to avoid inhalation of noxious fumes.

4. Introduce the cleaning solution to the softening unit at a flow rate of ~ 0.25 gpm/cu.ft. The second or third bed volume of cleaning solution should be retained in the resin bed (soaking period) for 3-5 hours. Heating of the cleaning solution to 95-100 ^{O}F will improve cleaning performance.

5. After passing the last bed volume of cleaning solution through the resin bed, the softener unit should be rinsed with softened water (3-5 bed volumes) and backwashed for approximately one hour.

6. The resin bed is then double regenerated using a 10% brine solution prior to service.

SYBRON SRC-3010* contains a relatively strong mineral acid which will remove most inorganic materials, but more specifically aluminum from ion exchange resins while being relatively safe for most demineralizer systems. As with most equipment designs, the equipment manufacturer should be consulted prior to its use.

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SYBRON SRC-5000

(ALUMINUM FLOC CLEANING - SOFTENERS)

Commercial and light industrial

1. Prior to any cleaning procedure the resin should undergo an extended backwash to ensure that all suspended matter is removed.

2. The resin should then be regenerated with 15 to 20 lbs. of salt per cubic foot of resin to prevent any precipitates from forming. Rinse the brine from the resin bed using soft water. *Note: Air scour if possible.*

3. Prepare three to four bed volumes of solution containing approximately 4-5% (1 gallon product to 35 gallons water) Sybron SRC-5000 using softened water. Always add chemical to water, and prepare solution in well ventilated area to avoid inhalation of noxious fumes.

4. Introduce the cleaning solution to the softening unit at a flow rate of ~ 0.25 gpm/cu.ft. while draining from bottom of vessel. The second or third bed volume of cleaning solution should be retained in the resin bed, air lanced and let soak for 3-4 hours. Heating of the cleaning solution to 95-100 ^{O}F will make the cleaning method more effective.

5. After passing the last bed volume of cleaning solution through the resin bed, the softener unit should be rinsed with softened water and backwashed for approximately one hour..

6. The resin bed is then double regenerated using a 10% brine solution prior to service.

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PERIODIC MAINTENANCE CLEANING: If it is determined that aluminum along with other metals, such as iron or manganese, from a water supply may become a re-occurring problem to the ion exchange unit, a simple maintenance program should be instituted to keep the ion exchange unit relatively free of metal precipitates or foulants.

Sybron SRC-3011* or SRC-2011* are particularly well suited for for residential type applications where softening resins are often fouled with heavy metals.

On a periodic basis the household softener can be cleaned by mixing one gallon of softened water with one pound of SRC-3011* or SRC-2011* which will produce a concentrated solution. The solution is then combined with the saturated brine used to regenerated the softener resulting in a cleaning solution with a pH of approximately 2. After the solution-brine cleaning, the softening unit should be rinsed, backwashed and regenerated using salt only.

For commercial or industrial type softening units it is recommended to periodically rinse the resin bed with a 4-5% solution of SRC-2011, SRC-3010 or SRC-3011 which should keep the softening unit relatively free of foulants. Again, the manufacturer of the unit should be contacted to confirm the resistance of the materials of construction cleaning solution.

*** See product bulletins for detailed information**

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RESIN CLEANING - CALCIUM & BARIUM & MAGNESIUM

CALCIUM SULFATE: Modern, high capacity, cation exchange resins can become fouled with calcium sulfate ($CaSO_4$) when using sulfuric acid (H_2SO_4) as a regenerant.

With strong acid resins, the precipitate is generally found on the surface of the resin bead, which can normally be removed with the proper cleaning procedure if the resin is not too heavily fouled. On the other hand weak acid resins tend to foul throughout the resin bead structure, which can make weak acid resin clean up much harder to accomplish.

The calcium sulfate precipitate is normally caused by contacting the resin with too high of an acid concentration or too slow of an injection flow rate in the first step of the acid injection cycle. Although some super saturation does take place during the regeneration process, the actual solubility of calcium sulfate is very low at 0.2-0.3%.

For cocurrent regenerated, strong acid systems, the sulfuric acid concentration is usually limited to 2% in the first step of the acid injection cycle, while countercurrent, strong acid systems and weak acid systems are limited to 0.5-0.7% concentration and a minimum flow rate of 1.0 gpm/cu.ft. of resin in the initial stage of sulfuric acid regeneration.

Generally, the effect of calcium sulfate precipitation will be seen as an increase in sodium and calcium during the service cycle along with loss of throughput capacity. During the regeneration cycle a white powder-like precipitate may be observed in the regenerant effluent.

The removal techniques in use today involve the following procedures:

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SYBRON SRC 3011 OR SRC-3014

(CALCIUM SULFATE REMOVAL - CATION UNITS)

Commercial and light industrial

1. Prior to the cleaning procedure the resin should undergo an extended backwash (65%-70% expansion) using softened or DI water to ensure that all suspended precipitate is removed.

2. Prepare approximately 5 bed volumes of solution containing 5%-10% SRC-3014 or SRC-3011 in DI water. Always add the chemical to water and prepare solution in well ventilated area to avoid inhalation of vapors.

3. Introduce the cleaning solution to the cation unit at a flow rate of ~ 0.25-0.50 gpm/cu.ft.

5. The reaction between the cleaning solution and calcium sulfate is one of slow solubilization and repeated cleaning may be required.

6. After the final bed volume of cleaning solution has passed through the resin bed, the unit is rinsed with 4-5 bed volumes of softened water and then backwashed for one hour at 65%-75% expansion.

7. The cation unit is then double regenerated, rinsed and returned to service.

BARIUM SULFATE: Although barium is not seen as frequently as calcium in natural water supplies, due to its low solubility, barium is encountered in water sources that are influenced by run off from oil field drilling processes in which barium is used in the formulation of the drilling mud.

Barium sulfate is highly insoluble and usually collects around the underdrain collectors and strainers of the cation unit. In normal softening applications, the barium will slowly foul the cation resin due to the inability of the sodium chloride to remove it from the softening resin during regeneration. Similar cleaning procedures, such as the use of **SYBRON SRC-3011**to remove calcium sulfate have also been shown to be somewhat effective in removing barium.

CALCIUM CARBONATE: Calcium Carbonate fouling usually results from poor equipment design or poor operation of anion exchange system. Calcium Carbonate can precipitate in the anion resin bed of a two bed demineralizer train when the cation unit is overrun and hard water is allowed to intrude into the anion unit or when hard water is used in regeneration of the anion unit.

Frequently anion resins are used in the chloride form to remove various contaminants such as nitrates, sulfates, alkalinity and natural occurring organic materials from water supplies. When these systems are exposed to water supplies with high levels of hardness (> 15-20 gpg) calcium carbonate precipitation may occur. Again, **SRC-3011**, a multicomponent cleaning compound has proven to be quite effective in removing this foulant.

MAGNESIUM HYDROXIDE: Magnesium hydroxide which has a solubility of 1-2 ppm generally becomes a problem, as with calcium carbonate, when hard water is used as regenerant dilution water for caustic or caustic /brine solutions used in the regeneration of the anion portion of a two bed DI system or a chloride/hydroxide dealkalizer. Whenever hard water is exposed to high pH conditions in a resin bed, the precipitation of calcium carbonate or magnesium hydroxide becomes a possibility. **SYBRON SRC-5000** is the resin cleaner of choice

Sybron SRC-3014 and **SRC-5000** have been found to be most effective in removing the majority of foulants found on cation exchange resins. **SRC-5000** and **SRC-3011** are particularly effective in the removal of barium from strong acid resins and the removal of calcium from heavily fouled weak acid resins. Ion exchange resins severely fouled with calcium sulfate, barium sulfate, calcium carbonate or magnesium hydroxide may require a two step cleaning approach utilizing both **SRC-3011** and **SRC-5000**. Product bulletins should be consulted for more detailed information.

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RESIN CLEANING - ORGANIC FOULANTS

ORGANIC MATERIALS: The presence of naturally occurring organic matter in various water supplies has been observed for centuries. It is generally agreed that naturally occurring organic matter in water supplies is a mixture of substances which are chiefly complex, carboxylic acids (humic, fulvic and other acid types) of light or dark brown color derived from decaying vegetable matter. The actual composition of the organic material will depend on the variety of plant life in an area, and the stage of decomposition of the vegetable matter from which the tannins or humic acids were leached by the water.

This organic material is essentially colloid in nature and has the propensity to foul strong base anion exchange resins through a combination of adsorption and ion exchange. These large molecular weight organic materials will slowly diffuse into the resin matrix and have the ability to bond at several sites. Their large size allows the organic material to envelope and mask un-reacted exchange sites on the resin. These high molecular weight organic acids are not easily removed through standard regeneration techniques.

The fouling action of these organic materials on the anion exchange resin manifests itself in a demineralizer system through a variety of ways:

1. High Conductivity
2. Low pH
3. Higher Silica Leakage
4. Increased Rinse Requirements
5. Lost Capacity

Although natural occuring organic materials present in the most water supplies have been identified as the major cause of anion resin fouling in DI water treatment systems, other sources can also contribute to this "on going" problem.

A frequently overlooked source of organic fouling on anion resins is cation resin degradation products. As the cation resin, in a separate bed DI system, is degraded due to oxidative attack, active sites (SO_3^- groups) leave the cation resin and pass through to be deposited on the following anion bed as a foulant. To maximize resin life, oxidative attack (chlorine, ozone, etc.) on cation resins must be minimized, especially when catalyzed by metal foulants.

Industrial organic contaninants such as anionic polymers, detergents, and ligno sulfonic acids can also contribute to the resin fouling problem.

Many of the organic materials whether present in natural or contaminated water supplies also have the ability to complex various heavy metals (iron, copper, manganese), enabling them to bypass the cation resin and become irreversibly bound to the anion resin.

Styrene based macroporous anion resins have long been used to remove organic materials from water. These types of resins have worked well in some areas, but poorly in others. More recently, acrylic based resins have emerged on the market and in some cases showing improved results.

In other words, just because one type of anion resin works well at one particular site does not necessarily mean it will work just as well at other sites.

If organic fouling of an anion resin is suspected, a representative sample or the resin should be collected for routine laboratory analysis.

In addition, to laboratory testing, the following, quick, simple field test can be performed on representative samples to determine the relative degree of organic fouling on the anion resin.

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FIELD TEST FOR ORGANIC FOULING
(ANION RESIN)

PROCEDURE: The following field test for organic fouling of anion resin must be performed on freshly regenerated resin to differentiate between organic material that would normally be removed during a standard regeneration and organic material that would require additional cleaning to be removed.

1. **Measure into a 200 ml pyrex beaker approximately 100 mils of a 6% brine solution containing 2-5% sodium hydroxide.**
2. **Add approximately 50-75 mls of the suspected resin.**
3. **Heat to 120^{o}F and stir for 15-20 minutes and let stand for one hour.**
4. **Color of brine above resin layer indicates relative degree of organic fouling**

   A. **Clear - No Fouling**
   B. **Light Yellow - Moderate Fouling**
   C. **Amber - Medium Fouling**
   D. **Dark Brown - Heavy Fouling**

Cleaning of organically fouled resin is not a simple matter. The most common approach to the treatment of organically fouled anion resins involved the use of brine and caustic as standard cleaning agents. Several new cleaning products using brine and caustic with enhanced cleaning properties have now been developed by Sybron Chemicals Inc. The procedures for using the Sybron cleaning products are as follows:

RESIN CLEANING - ORGANIC FOULING

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SYBRON SRC-5000

(ORGANIC REMOVAL - STRONG BASE UNITS)

PROCEDURE: The following procedure is recommended as part of a general maintenance program aimed at minimizing organic fouling of strong anion exchange resins (Type 1 and Type II). It is suggested that the chemical treatment be performed at least every six months, or more frequently as required, depending on the variability and TOC content of the raw water supply.

Sybron Chemical has several approaches to the use of brine, caustic and **SRC-5000*. Sybron SRC-5000*** is a specially formulated alkaline cleaner containing organic dispersants, chelate compounds and cleaners. The following cleaning procedure has been found to be most effective in removing heavy, naturally occurring organic materials from anion exchange

1. Prior to any chemical treatment, the resin bed should be backwashed with softened or DI water for 1-2 hours at a backwash rate that expands the resin bed a minimum of 65%-70%.

2. Prepare a solution containing 3%-5% caustic (2-4 lbs. NaOH) and 0.5-1.0 lbs. of SRC-5000 per 10 gallonsof DI water, and a second solution containing 5%-7% NaCl. The volume of each cleaning solution required will depend on the degree of organic fouling, but will normally range between 4 and 7 bed volumes of each solution (30-50 gals/cu.ft. of resin). Some conditions may require repeated cleanings.

3. For maximum cleaning efficiency, both cleaning solutions should be heated and contacted with the resin warmed to (115-120^{O}F for Type I strong base resins and 90-95^{O}F for Type II strong base resins). Care must be taken that maximum temperature limits are not exceeded during the treatment period.

4. Using the existing caustic distributor, pass the NaCl solution slowly (0.20-0.30 gpm/cu.ft.) through the exhausted resin while allowing the unit to drain. The flow rate should not exceed the flow rate used during the normal caustic injection cycle. Preferably, the resin bed should be preheated to the desired temperature prior to the passage of the brine through the resin bed.

5. Using the caustic dilution system, rinse the resin bed with four bed volumes (30 gals/cu.ft.) of decationized or demineralized water at a flow of 0.25-0.5 gpm.cu.ft. of resin. The temperature of the rinse water should be maintained at the same temperature as the cleaning solutions.

6. Using the caustic distributor pass the caustic/SRC-5000 cleaning solution through the resin bed at a flow rate of 0.25-0.50 gpm/cu.ft. of resin.

7. Observe the color of the last two bed volumes of the caustic/SRC-5000 exiting the resin bed. If a light-dark tea color remains, the cleaning solution should be rinsed from the resin bed using 4-5 bed volumes of decationized or demineralized water and a second cleaning performed.

8. After final cleaning and rinsing have been completed, the resin bed should be double regenerated with NaOH, rinsed and returned to service.

*** See product bulletins for detailed information**

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SYBRON SRC-5000

(ORGANIC REMOVAL - ALTERNATE)

PROCEDURE: The following procedure can be used as an alternate method to clean both single anion units and mixed bed units. The frequency of using this procedure will depend on the level of TOC in the influent water supply and its variability throughout the year. The use of organically resistant resins, such as macroporous or acrylic anion exchange resins, does not always guarantee fouling of the resin will not take place. It is good practice to periodically chemically clean organically resistant resins at least once a year to remove as much organic material as possible.

1. Prepare a solution containing 3%-5%% caustic (2-4 lbs. NaOH/10 gallons) along with (0.5-1.0 lbs./10 gallons)of SRC-5000 and 5%-7% (4-6 lbs./10 gallons) NaCl using soft or DI water. At least 4-5 bed volumes of the cleaning solution are required for single anion units and 4-6 bed volumes (cation plus anion resin) for mixed bed units. The cleaning solution should be heated to 95^{O}F prior to its use. *NOTE: The resin should be in the exhausted state.*

2. With the water in the anion unit drained down to within 3-6 inches of the top of the resin and the top manway open, the first bed volume of cleaning solution should be passed through the resin bed at a flow rate of 0.20-0.40 gpm/cu.ft. of resin, while allowing the anion unit to drain at a flow rate that maintains the level of cleaning solution 4 inches above the surface of the resin bed.

3. The third bed volume of cleaning solution should be introduced at the same flow rate and then retained in the resin bed for a minimum of 8 hours or over night if possible. Periodic air mixing with an air lance will ensure good contact between the fouled resin and the cleaning solution.

4. At the end of the chemical soak, the last bed volume of cleaning solution is slowly passed through the resin bed. Observe the color of the last bed volume of cleaning solution exiting the resin bed. If a light-dark tea color persists, a second cleaning should be performed. *Note: Other cleaning methods include recirculating the cleaning solution with a pump/chemical makeup tank until color develops. This is followed by repeated cleaning cycles with clean solution until fresh cleaning solution remains clear.*

5. After replacing the manway cover, the anion unit is rinsed free of brine with decationized water, and double or triple regenerated with caustic soda using 8-10 lbs. per cubic foot of resin. A displacement or slow rinse should be introduced between each caustic injection cycle.

6. For mixed bed systems, both the cation and anion resins must be contacted with the cleaning solution using the same procedures as listed above. Prior to any cleaning, the mixed bed must be neutralized or "killed" using 10-15 lbs. of salt per cubic foot of mixed bed resin introduced as a 5%-8% solution. After the final rinse, the mixed bed unit is backwashed for 20-30 minutes and double or triple regenerated using 10-12 lbs of 100% acid and caustic with a complete displacement rinse between each acid or caustic injection step.

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SODIUM HYPOCHLORITE CLEANING
(ANIONS - ORGANICALLY FOULED)

PROCEDURE: This procedure is only used when standard chemical cleaning methods are shown to be ineffective or when the resin is so heavily organically fouled that speciality chemical cleaners shows no substantial improvement in performance and resin replacement is the only alternative. This cleaning procedure is **suitable for occasional use only** on any one charge of resin due to the oxidative attack of this compound on ion exchange resins.

1. Prior to any cleaning procedure the resin should undergo an extended backwash to ensure that all suspended matter is removed.

2. Anion resin should be treated with at least 1-3 bed volumes of 10% brine solution at a flow rate of 0.3-0.5 gpm/cu.ft. of resin to ensure the anion resin is in the chloride form and to remove any lightly held organic materials.

3. Prepare 1-2 bed volumes of a 10% sodium chloride solution containing sufficient commercial sodium hypochlorite to obtain approximately 1% free chlorine.

4. The sterilizing solution is then passed through the resin bed, one bed volume at a time, at a flow rate of 0.5-1.0 gpm/ cu.ft. of resin.

5. After passing the last bed volume of solution through the resin bed, the flow should be stopped, and the solution held in contact with the resin for 2-4 hours. The ion exchange unit should be vented at this time.

6. At the end of this contact period, the remaining bed volume of solution should be passed through the resin bed.

7. The anion unit is then rinsed with water until free of solution and double regenerated with sodium hydroxide or sodium chloride applying a slow rinse between each caustic or salt injection cycle.

Note: Sodium hypochlorite is a strong oxidizing agent and proper handling procedures should apply. All drains containing waste solution should be rinsed clean. Acid should not come in contact with cleaning solution due to generation of gas. Consult chemical your chemical supplier for availability of proper handling procedures. When handling or storing this material adequate ventilation must be provided. Consult MSDS data sheet before handling.

Note: Cleaning products can cause severe burns and requires special handling and storage procedures. Some products may be corrosive to unprotected steel and may be incompatible with materials of construction utilized in the ion exchange unit. When handling or storing this material adequate ventilation must be provided. Consult product bulletins and MSDS data sheet before handling.

POLYELECTROLYTES: Polyelectrolyte polymers are added to some water supplies at ppm levels to improve clarification and act as a coagulant aid. Cationic polyelectrolytes are known to react with humic substances and can be a highly effective means of reducing or eliminating organic fouling of anion exchange resins.

The same chemical properties which make cationic polymers so effective in water clarification can also create potential fouling problems for cation exchange resins.

Fouling of the cation exchange resin is normally associated with upset conditions in the pretreatment system, due to equipment failure or extreme variations in the raw water supply, resulting in higher than normal polyelectrolyte levels in the treated water supply to the demineralizer system..

The degree of fouling and the ease of its removal from the resin will not only depend on the polyelectrolyte level in the treated water supply, but also on the charge density, molecular weight, monomer composition of the polymer and the specific composition of the water being processed.

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SYBRON SRC-5000
(CATION - POLYELECTROLYTE)

PROCEDURE: In some cases, depending on the type of polymer being used, cleaning the resin with a 3%-4% solution of Sybron **SRC-3014*** will remove the majority of the polymer from the resin. Where acidic type cleaners are not successful, the following procedure should be used.

1. Prior to cleaning, the resin should undergo an extended backwash (65%-70% expansion) using softened water to ensure that all suspended precipitate is removed and the cation resin is converted to the sodium form (10-15 lbs. salt/ cu.ft. of resin).

2. Prepare approximately 4-5 bed volumes of solution containing 4%-5% SRC-5000*(1-2 lbs./10 gallons). Always add the chemical to DI or softened water and prepare solution in well ventilated area to avoid inhalation of vapors.

3. Introduce the cleaning solution to the cation unit at a flow rate of ~ 0.25 gpm/cu.ft. For maximum cleaning efficiency the cleaning solution should be heated to 120°F.

5. After the third or forth bed volume, the cleaning solution should be retained in the resin bed for 4-5 hours.

6. At the end of the chemical soak, the last bed volume of cleaning solution is slowly passed through the resin bed.

7. Rinse the resin bed with several bed volumes softened water to ensure that all cleaning solution has been removed from the vessel.

8. Double or triple regenerate with acid or salt to ensure the cation resin is converted to the proper form . A slow rinse should be used between each injection cycle.

*** See product bulletins for detailed information**

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RESIN CLEANING - OIL AND GREASE

OIL, GREASE: Occasionally, ion exchange resins may become fouled with oils, grease, proteins or nitrogenous matter to such an extent that both the exchange capacity and exchange rate of the resin may be affected.

Oil ingress into the water supplies may occur in a number of ways which include: leaking seals from pumps or compressors, or direct oil contamination of a water source as in the case oil field produced water systems.

Whatever the source, the effect of oil fouling is the formation of an oil film around the resin beads, which can in severe cases, cause abrupt loss of capacity in an ion exchange system. These contaminants can also cause resin beads to clump together disturbing the normal flow of water through the ion exchange unit or when attach to the resin beads can increase the buoyancy of the resin resulting in resin loss during backwash. Due to the fact that some lubricating oils contain fluorescent additives, in many instances oil fouling may be detected by UV light.

In water systems where oil or grease ingress is a continuing problem, pretreatment is not only recommended, but required.

For mineral oil fouling, frequent contact with warm caustic (4-5% at 95^{O}F), will remove the mineral oil from the resin, however, this may not be successful with all types of oil.

The most promising method for the removal of oil from resin beads is the use of surfactants. Using the right balance of salts and surfactants, an aqueous cleaner has the capability of penetrating the thin film of oil surrounding the resin bead and either emulsifying or lifting the oil to the surface of the cleaning solution.

Sybron Chemical Inc. has developed a unique combination of salts and surfactants designated as the **SRC-7400*** series which show good performance for the removal of oil from resin beads.

The procedure for cleaning oil fouled ion exchange resin using Sybron **SRC-7400*** is as follows:

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SYBRON SRC-7400

(RESINS - OIL FOULED)

Commercial and light industrial

1. Prior to any cleaning procedure the resin should undergo an extended backwash to ensure that all suspended matter is removed.

2. The water level in the oil fouled unit should be drained to 6 inches above the resin bed.

3. Prepare a <1% (1 gallon of product to 40-70 gallons of water) solution of SRC-7400*using softened or DI water. The quantity of solution should be enough to completely immerse the resin bed in the cleaning solution.

4. Add the concentrated cleaning solution through an open manway to the water above the open bed, avoiding any fumes.

5. Slowly drain cleaning solution through fouled resin until 6-12 inches of cleaning solution remains at the top of the

6. More efficient cleaning will result if cleaning solution is heated to 80-90^{O}F.

7. Air agitation should take place during the contact period for approximately 45 minutes (see page B.)..

8. The oil fouled resin should remain in the cleaning solution for approximately 2 hours.

9. Following the soaking period warm water is introduced slowly through the bottom of the vessel to within 2 feet of the open manway. The resin is then backwashed for one hour to remove the bulk of the oily contaminant. The backwash rate must be watched carefully to avoid resin loss.

10. The resin is then rinsed with warm water to remove all traces of the cleaning solution. The resin is doubled regenerate, rinsed and returned to service.

11. Check the effect of the treatment by means of repeated capacity tests.

Note: Cleaning products can cause severe burns and requires special handling and storage procedures. Some products may be corrosive to unprotected steel and may be incompatible with materials of construction utilized in the ion exchange unit. When handling or storing this material adequate ventilation must be provided. Consult product bulletins and MSDS data sheet before handling.

*** See product bulletins for detailed information**

The data included herein are based on test information obtained by Sybron Chemicals Inc. These data are believed to be reliable but do not imply any warranty or performance guarantee. We recommend that the user determine performance by testing on his own processing equipment. We assume no liability or responsibility for patent infringement resulting from the use of this product.

RESIN CLEANING - SULFUR AND SILICA

SULFUR: Sulfur is usually found as H_2S (Hydrogen Sulfide) in well waters or contaminated surface water supplies and is detected by its characteristic rotten egg odor.

In its gaseous form H_2S has little effect on ion exchange resins. However, it can be a cause of marked corrosiveness of waters to metal and concrete. It can also combine with other contaminants in the water supply such as iron, manganese or sulfite to form dark greasy deposits of metallic sulfides which can foul piping and coat resin beads.

Sulfides also have the ability to promote the growth of various filamentous sulfur bacteria, leading to localized pitting and corrosion of water supply lines, general degradation of the water supply and the formation of encrustations and slime deposits that can foul ion exchange resins.

The best and simplest approach in limiting the growth of these microorganisms is the use of oxidizing agents such as chlorine.

Once the resin bed is cleaned, the complete water system, including the well, should be sterilized.

Common water softener cleaners will not remove the hard, tenacious metal sulfide deposits from the ion exchange resin bed. For domestic or commercial softening units, the resin should be removed from the softening unit and treated separately using a strong acid cleaner such as Sybron **SRC-3010*** or **SRC-3014*** using the following procedure:

****

SYBRON SRC-3014/3010

(METALLIC SULFIDES - SOFTENERS & CATION UNITS)

Commercial and light industrial

1. Thoroughly backwash the resin bed to remove all loose dirt and debris.

2. For softening units, regenerate the resin bed with sodium chloride, using 15-20 lbs. of sodium chloride per cubic of resin. Rinse water from the resin bed using soft water. For DI systems, the cation unit should be in the regenerated state.

3. Drain the water from the unit to a level of approximately six inches above the resin bed.

4. Introduce a 10% solution of SRC-3014* or SRC-3010* at a flow rate of 0.25 gpm/cu.ft. The cleaning solution should be applied at 15-25 lbs./cu.ft. of resin. If possible the solution should be heated to 95^{O}F prior to introduction for better results.

5. For heavily iron fouled resins, the final bed volume of cleaning solution should be retain in the resin bed for a period of 5-10 hours.

6. With softening units, the cleaning solution should be completely drained and rinsed using softened water, and then backwashed for 30-60 minutes. Double regenerate with salt and rinse with softened water prior to service.

7. For hydrogen form cation units drain and rinse using normal rinse down procedures. Backwash for 30-60 minutes to remove loosened crud and regenerate and return to service.

SILICA: Silica fouling can occur on anion resins used in the demineralization of water supplies. When strong base resins are used to remove soluble silica from water supplies, silica can accumulate on the resin when proper regeneration techniques are not being observed.

If the anion resin is not being regenerated properly, a portion of the silica on the resin bed can hydrolyze to soluble silicic acid which polymerizes to colloidal silicic acid on the surface and inside the pores of the resin beads.

Strong base, type 2 resins are quite susceptible to this type of occurrence due to the lower caustic levels normally used to regenerate the resin. Although the caustic level being used may be high enough to obtain the required capacity, from the more efficiently regenerated type 2 resin, it may not be at a sufficient level to solubilize and remove the silica from the resin bed which results in unexpected silica leakage during the demineralization process. Silica fouling is further complicated in the presence of organic foulants.

Silica fouling can also occur in weak base anion units, particularly when they are part of a three bed demineralization system, i.e.. (strong acid- weak base- strong base), and the caustic waste regenerant from the strong base unit is used to regenerate the weak base resin.

Mixed bed and countercurrent designed anion units are also quite susceptible to silica fouling, especially with water supplies containing high levels of silica.

When silica fouling does occur, the following procedure should be applied:

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SILICA REMOVAL
(STRONG AND WEAK BASE RESINS)

1. Prior to the cleaning procedure, the resin should undergo an extended backwash (65%-70% expansion) using DI water to ensure that all suspended matter is removed.

2. The resin should then be double regenerated using 12-14 lbs of NaOH per cubic foot of resin as a 4%-5% solution at a flow of 0.20-0.25 gpm per cubic foot of resin. Time and temperature are critical in the removal of precipitated silica. The caustic solution should be preheated to 120^{O}F for weak base and Type 1, strong base resins and 95^{O}F for Type 2, strong base resins. DI water should be used to prepare the caustic solution and rinsing. Where silica fouling is extremely severe, or organics along with heavy metals is part of the fouling problem, the use of SRC-5000* at 0.5-1.0 lbs. per 10 gallons of caustic solution will improve the performance of the cleaning solution.

3. For heavily fouled resin, it may be necessary to let the resin soak in the caustic solution over night, followed by a final regeneration.

4. The resin is then slow rinsed with warm DI water to remove all traces of the caustic solution, followed by a standard fast rinse to quality.

*** See product bulletins for detailed information**

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RESIN CLEANING - MICROORGANISMS

MICROORGANISMS: A general problem for ion exchange resins is the tendency for algae, bacteria, viruses and fungi to be attracted to resins. All ion exchange resins as produced have growth to some degree on the resin surface.

Since living systems consist of membranes which have the properties of ion exchange materials, it is not surprising that there is an interaction at their surface.

The fixed negative charge of the cation exchange resin will attract positively charged bacteria, viruses and fungi, while the positive charge on anion exchange resin will attract negatively charged bacteria.

The capacity of ion exchange resins can be quite high for microorganisms. Anion exchange resins have capacity values ranging from 2×10^4 to 6×10^9 cells / cm^2, while cation exchange resins have much lower capacities at 2×10^4 cells / cm^2.

In certain cases, biological growth can be so extreme as to interfere with flow patterns resulting in channeling and high pressure drop across the resin bed.

Early tests performed on two-bed ion exchange system showed that standard regeneration techniques had the ability to suppress biological activity in ion exchange systems. With a more frequent regeneration schedule, a lower level of biological activity was found in the resin bed.

The difficulty in controlling bacterial contamination in ion exchange beds is well known to the semiconductor and pharmaceutical industries, where installations of UV lights and fine filters as well as frequent sterilization of the resin beds with formaldehyde, hydrogen peroxide, hot water rinse and other agents have all been employed to reduce microorganism growth. Since the use of formaldehyde is no longer acceptable, other means for control are now receiving attention.

The use of oxidants to control biological activity in resin beds must be considered with some caution. The majority of ion exchange resins are produced from polymers consisting of a styrene-divinylbenzene matrix, which can become decrosslinked when exposed to high levels of oxidizing agents such as chlorine, ozone and peroxide. Although all of these oxidizing agents have a broad spectrum of kill, prolonged contact with ion exchange resins will cause the moisture holding properties of the resin to increase and result in softening of the resin structure. An occasional treatment (2-3 times per year) with some oxidants will not greatly change the resin, but leachables from the resin can be expected to increase.

Sybron Chemicals Inc., presently offers two cleaning solutions formulated to reduce the affects of the strong oxidizing agents. These products are designated as **SRC-8005*** and **SRC-8009***. Both products when applied properly will suppress biological activity in the resin bed, while having minimal effect on the performance of the resin.

Note: All surfaces of the resin and vessel must come in contact with the solution for the sterilizing procedure to be effective.

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SYBRON SRC-8005

(SOFTENERS - BIOLOGICAL FOULING)

1. Prior to the cleaning procedure the resin should undergo an extended backwash (65%-70% expansion) using softened water to ensure that all unwanted debris is removed.

2. The softening resin is then regenerated using 15-20 lbs. of sodium chloride per cubic foot of resin. Rinse brine from resin bed using softened water.

3. Prepare approximately 1-2 bed volumes of solution containing <1% SRC-8005. Always add chemical to water and prepare solution in well ventilated area to avoid inhalation of vapors.

5. Pass sanitizing solution through resin bed at the normal regeneration flow rate.

6. When the last bed volume of sanitizing solution has been passed through the resin bed, allow the resin bed to soak in the solution for approximately one hour. After the soaking period, the last bed volume of cleaning solution is passed through the resin bed.

7. Rinse out cleaning solution with raw water for 60 minutes at normal displacement flow rate followed by normal fast rinse for 45 minutes.

8. Backwash, double regenerate softening unit and return to service.

****

SYBRON SRC-8009

(CATIONS, ANIONS,MB - BIOLOGICAL FOULING)

Commercial and light industrial

1. Prior to the cleaning procedure the resin should undergo an extended backwash (65%-70% expansion) using softened water to ensure that all unwanted debris is removed.

2. The resin is then exhausted using 13% solution at 10-15 lbs. of sodium chloride per cubic foot of resin. Rinse brine from resin bed using softened water.

3. Prepare approximately 3 bed volumes of solution containing 1.0%-1.5% SRC-8009 (1 gallon to 100 gallons of water). Always add chemical to water and prepare solution in well ventalated area to avoid inhalation of vapors.

5. Pass cleaning solution through resin bed at the normal regeneration flow rate. When the last bed volume of cleaning solution has passed through the resin bed, allow the bed to soak in the solution for 1-2 hours.

6. After soaking period ends, carry out normal displacement rinse using raw water for 60-80 minutes, followed by normal fast rinse for 45 minutes. Backwash, double regenerate resins and return to service.

*** See product bulletins and MSDS for detailed information on storage and use.**

The data included herein are based on test information obtained by Sybron Chemicals Inc. These data are believed to be reliable but do not imply any warranty or performance guarantee. We recommend that the user determine performance by testing on his own processing equipment. We assume no liability or responsibility for patent infringement resulting from the use of this product.

RESIN FINES AND OXIDANTS

RESIN FINES: Normally, standard grades of ion exchange resin are supplied in the particle size range of 16-50 U.S. mesh (0.297-1.19 mm). Unless special particle size requirements are requested, a typical production specification on particle size will designate 98-99% cumulative beads retained on a particular mesh screen (1-2% passing through a 50 mesh screen). The 1-2% whole beads passing through a 50 mesh are classified as fines and, from the standpoint of increased pressure drop or channeling, has no real significance.

However, repeated cycling of the resin through its regeneration and service cycles subjects the resin to physical shock. As the resin ages, the effects of osmotic shock, mechanical attrition and temperature result in the physical breakdown of the resin bead into small irregular fines. This increase in the level of resin fines alters the packing characteristics of the resin bed, by decreasing the interstitial void volume, resulting in increased pressure drop.

As these conditions continue in subsequent cycles of operation, the resin fine levels and pressure drop will continue to increase.

If these resin fines are not removed during normal backwash of the resin bed, the fines will collect at the top of the resin bed as a filter cake, resulting not only in an elevated pressure drop, but possible channeling of both regenerant and service water. The affects will be seen in the form of reduced capacity, poor quality water and high pressure drop.

If it is determined that a build up of resin fines in the resin bed is a possible problem, the following procedure should be implemented;

****

RESIN FINES REMOVAL

1. The ion exchange unit in question is first put into its normal backwash mode for 1-2 hours.

2. Samples of backwash water should be taken at regular intervals to determine if any resin fines or resin beads are in the backwash water exiting the unit.

3. If resin fines or resin beads are not found in the water exiting the unit, the backwash flow rate should be increased slowly The flow rate should be controlled manually via the backwash outlet valve.

4. As the backwash flow rate is increased, samples of the backwash water should be taken in small white paper cups. The resin fines will tend to collect in a circular pattern toward the center of the cup. The diameter of the circular pattern should be no greater than a 50 cent piece - a larger diameter pattern indicates that the flow rate is too high.

5. The contents from the sample cup should be examined under a microscope to determine whether resin fines or whole resin beads are being backwashed from the unit. If resin fines are being discharged from the unit, the backwash should continue until the backwash water is clear and clean. On the other hand, if whole resin beads are being backwashed from the unit, the backwash flow rate should be reduced and samples taken for further examination.

NOTE: In some extreme cases where the resin fines are packed tightly, possibly due to precipitated or filtered matter, air scouring and chemical cleaning of the resin bed may be necessary prior to backwash.

OXIDANTS: Oxidizing agents such as chlorine or ozone, which are normally used for the control of microorganisms in water supplies, can attack and, under the right conditions, rapidly degrade ion exchange resins.

Free chlorine levels in excess of 0.1-0.3 ppm coupled with low pH and trace levels of iron, copper, manganese or chromium can result in the decrosslinking of the ion exchange resin.

The heavy metals act as catalysts along with low pH and high temperature to increase the rate of the resin degradative reaction.

Ozone is more reactive than chlorine and is generally limited to 10-20 ppb in the influent water.

Decrosslinking of the ion exchange resin results in the resin becoming less dense, along with increased water retention, capacity loss and a tendency to compact more easily, which can effect pressure drop.

Although the lead cation unit is most affected by these oxidizing agents, anion resins following the lead cation unit are also subjected to degradation. Not only is the anion resin exposed to oxidants that get by the cation unit, but are also exposed to water soluble, degradation products from the lead cation unit which can irreversible foul the anion resin.

Once the cation or anion resin is degraded there is no method presently available to recover lost capacity or improve the performance of the resin.

The best approach is to limit the levels of oxidants reaching the resin beds i.e. (activated carbon, sulfite addition, etc.).

In situations where the oxidant levels can not be controlled, higher crosslinked, macroporous resins should be considered.

RESIN CLEANING - AIR LANCE ARRANGEMENT

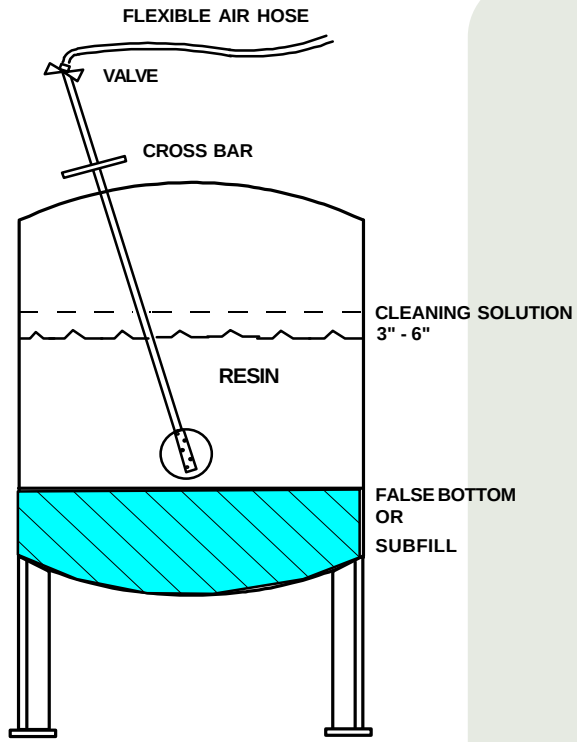

Figure 1. AIR LANCE ARRANGEMENT

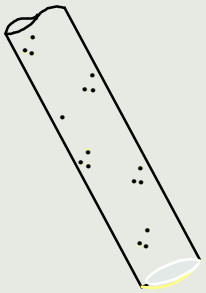

Figure 2. PERFORATED AIR SPARGER

AIR LANCE: Several factors can affect the removal of various contaminants by interfering with the actions of ion exchange resin cleaners. The most obvious is contaminant loading. On heavily fouled resin beds, a cleaning solution can become saturated with soils or materials that can inhibit the action of the cleaning solution. In this instance repeated cleaning may be necessary.

An important and often overlooked factor affecting the performance of a resin cleaner is its distribution throughout the resin bed. For a cleaning solution to be most affective, it is necessary for the solution to be uniformly distributed throughout the resin bed.

Partial cleaning of a severely fouled resin bed, due to improper chemical concentrations or poor distribution, may only serve to make matters worse by redistributing or redepositing contaminants onto the surface of other ion exchange beads.

When a resin bed is severely fouled as indicated by a resin analysis or reduced performance in terms of lost capacity and poor water quality, in-bed resin cleaning may be required.

One of the most effective methods of providing good distribution and resin contact with the cleaning solution is the use of an air lance, utilizing air or nitrogen to provide the mixing action. The air lance is also useful in breaking up precipitates or suspended matter that collect or deposit on the surface of the resin bed. Its scrubbing action serves as an aid to the cleaning solution in the removal of foulants from the surface of the resin beads.

Figure 1., shows a typical air lance arrangement. The air lance is constructed of 1/2" to 3/4" schedule 40 pipe equipped with an adjustable cross bar and air control valve. Depending on the size and depth of the resin bed, the flow of air should be set at a rate that produces maximum agitation and mixing of the resin bed. Care must be taken to avoid damage to the underdrain collectors or disruption of any subfill/ distribution media used in some resin equipment designs.

Figure 2., is a detailed diagram of the sparging tip of the air lance. This part of the air lance is usually drilled with 5-6 holes of 1/8" diameter, spaced 1-1/2 to 1-3/4 inches apart. From the bottom of the lance, the holes are rotated 72 degrees apart to form a spiral design. The bottom of the sparging tip is capped which forces the air to the side maximizing the mixing action.

As an alternative, air or nitrogen can also be percolated up through the bottom collector. Again, the flow of air must be high enough to result in good mixing of the resin.

PROCEDURE FOR TAKING RESIN SAMPLES

RESIN SAMPLES: The first step in determining the condition of any ion exchange resin is to collect a sample, or samples which are representative of the entire resin bed. Generally the larger the exchange unit the more sampling required.

The methods used to collect resin samples for laboratory analysis can be categorized into three groups; grab samples, core samples and composite samples.

Grab samples are resin samples taken randomly from the top of the resin bed and is not the best method of obtaining a representative sample. Ion exchange resin beads located at the top of the resin bed are generally those in the poorest condition i.e.., (fouled, oxidative attack, precipitates, suspended solids and resin fines).

Core samples of resin are much more representative of the cross-sectional area of the resin bed and for small ion exchange units can safely represent the entire bed. Core samples are usually taken using a grain thief, thin walled conduit or pipe as shown in Figure 3.

Composite samples of resin are usually a combination of core samples taken from four quadrants of a resin bed as shown in Figure 4. The resin samples can be tested separately or mixed and submitted as a composite sample for analysis. This sampling technique is normally used for relatively large ion exchange systems.

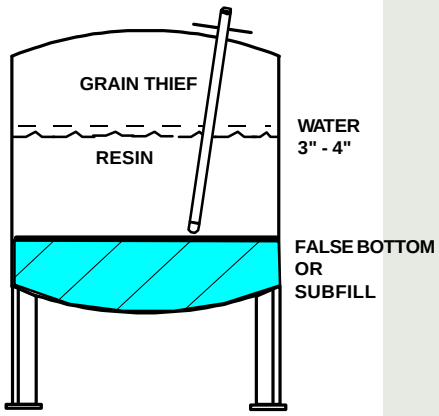

Figure 3. CORE SAMPLES - ION EXCHANGE RESIN

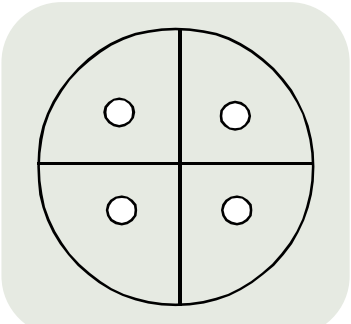

Figure 4. VESSEL CROSS SECTION-SAMPLE QUADRANTS

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GENERAL PROCEDURE
RESIN SAMPLES

1. Fill out an identification label listing type of resin and designating the ion exchange unit from which the sample is taken.

2. Record identification, sampling data, operating data, and statement of problem in the spaces provided on the data sheet (Sybron Form 506).

3. Drain resin bed so that water level is a few inches above the top of the resin bed.

4. Insert a grain thief or thin walled 3/4" diameter conduit through open manway. Push the grain thief downward until reaching the false bottom or support material below the resin bed and rotate the sampler or cap the conduit and withdraw slowly. Care must be exercised not to damage the underdrain collection system when taking resin samples.

5. Empty the contents of the sampler into a clean container containing water from the operating unit. If necessary repeat this procedure in different areas of the resin bed until one pint of resin has been obtained.

6. If limited overhead space prevents core sampling, obtain resin sample by first scraping 1-2 inches from the surface of the bed, and then obtain equal portions from the area at the 3-6 inch level, 12-15 inch level, and 18-24 inch level. Identify this as a composite sample.

7. Sufficient resin sample should be collected for analysis. Quantities required for evaluation are as follows:

Cation/Anion (Separate Beds) ..... 1 Pint
Mixed Beds ..... 1 Quart

8. Transfer the resin sample to a plastic sample bottle (labeled), and completely fill with water from the operating unit.

9. Seal bottle tightly and place in suitable shipping container along with Sybron Form 506.

NOTE: Resin samples should be in the regenerated state when laboratory testing for conversion or foulants is required. This removes foulants that would ordinarily be removed during the normal regeneration cycle.

RESIN ANALYSIS & INTERPRETATION

RESIN ANALYSIS: The life expectancy of an ion exchange resin is dependent on many factors which include; type of resin, cycles of operation, age, influent water characteristics (foulants, oxidizing agents, temperature, etc.), regenerant type and quality, system design, and operator training.

All of these factors, to some degree, will have an effect on the performance and operating life of an ion exchange resin.

To determine the chemical and physical condition of ion exchange resin that have seen service in the field, a number of laboratory tests have been developed that compare the condition of the used resin to that of a new resin.

These laboratory tests will also determine the extent to which foulants, oxidants or other contaminants in the water supply may be effecting the performance and life expectancy of the resin.

Well developed resin testing laboratories, such as those at Sybron Chemicals Inc., will also be able to suggest various pretreatment methods and/or cleaning methods that may be useful in extending the useful life of the resin.

The following is a listing and discussion of the various laboratory tests conducted on resin samples received from the field;

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SYBRON LABORATORY TESTING
(CATION RESINS)

TOTAL CAPACITY: Total capacity is the ultimate ion exchange capability for the cation exchange resin. Total capacity relates to the total number of functional groups on the polymer matrix. For new, standard 8% crosslinked cation resin i.e.(**Ionac C-249**), the total capacity value should be approximately 2.0 meq/ml. The total capacity can be lost through aging, fouling or oxidation. Generally, a 15% nonrecoverable loss in total capacity indicates that resin replacement may be necessary.

WATER RETENTION: Water retention is the amount of water (expressed as a percentage of the wet weight) retained within and on the surface of a fully swollen and drained ion exchange resin. An increase in the water retention can indicate that the resin has been attacked by an oxidizing agent, i.e.. (chlorine, ozone). The increase in water retention is usually accompanied by a loss of both total and operating capacity. A decrease in water retention may be caused by extreme fouling. For new, 8% crosslinked cation resin (**Ionac C-249**), the water retention will range between 45%-48%. Higher crosslinked cation resins will have lower water retention values.

MICROSCOPIC EXAMINATION: This test, also known as bead count, indicates the percentage of resin beads in a resin sample that are whole, cracked or broken. All beads examined should fall into one of these three categories. It is very important that a representative sample is taken. When the sample is taken from the top of the resin bed, the percentage of cracked or broken beads will normally be much higher than when a core sample is taken. If a large number of broken beads are present in a representative sample, pressure drop or channeling of flow may be experienced by the demineralizer unit. To remove the resin fines see backwash method under "fines removal" in this paper.

IRON FOULING: One of the major foulants of cation resin is iron which can exist in various forms in natural water supplies. The iron fouling test shows the grams of iron present per cubic foot of resin. The following scale shows how reported iron levels relate to level of fouling. This scale for iron fouling is only applicable to results from Sybron's Field Samples Laboratory.

0 - 2 grams/cu.ft.	**3 - 6 grams/cu.ft.**	**over 6 grams/cu.ft.**
LOW	**MEDIUM**	**HIGH**

Similar scales are also available for aluminum, copper and barium foulants. See cleaning methods for iron removal in this paper.

% CONVERSION: This laboratory test is performed to determine the effectiveness of the resin regeneration process. This test is performed on the resin in the "as received" condition. In order for this test to be meaningful, the resin should be regenerated by the customer on site prior to sampling. When the hydrogen conversion is between 70% and 80%, the regeneration procedure being used in the field is considered satisfactory. If the hydrogen conversion is well below 70%, the regeneration procedures being used by the customer should be reviewed.

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SYBRON LABORATORY TESTING
(STRONG BASE ANION RESINS)

TOTAL CAPACITY: Total capacity for a strong base resin is the sum of the strong base capacity and weak base capacity. Normally, the total capacity of a strong base resin is not lost as quickly as the strong base or salt-splitting capacity. The salt-splitting capacity of a strong base resin is the capacity used to pick up weak acids such as carbon dioxide or silica from the water supply. A new Type 1 anion resin, such as **Ionac ASB-1**, will normally have a total capacity of 1.35 meq/ml, while a new Type 1 porous anion resin such as **ASB-1P** will have a total capacity of 1.3 meq/ml. New Type 2 strong base resins will normally have a total capacity of 1.35 meq/ml. Total capacity can be lost from the resin through aging, fouling and oxidation.

SALT-SPLITTING: Salt-splitting capacity is the measure of an anion resin to remove weak acids such as silica or carbon dioxide. The term salt-splitting capacity is synonymous with strong base capacity. For a new strong base anion resin, the salt- splitting capacity is normally 90%-95% of the total capacity.

Strong base resins (especially Type 2 anion resins) can lose 20%-25% of their salt-splitting capacity during the first year of use. This rate of loss usually decreases over time. The loss of salt-splitting capacity is actually a conversion of the strong base capacity to weak base capacity, with little affect on total capacity. The loss of salt-splitting capacity can also be attributed to organic fouling or oxidation.

WATER RETENTION: As with cation resins, water retention is the amount of water (expressed as a percentage of the wet weight) retained within and on the surface of a fully swollen and drained ion exchange material. An increase in the water retention can indicate that the resin has been attacked by an oxidizing agent (i.e.. chlorine). This increase in water retention can result in a loss of both total and salt-splitting capacity. A decrease in water retention may be caused by extreme organic fouling. New **Ionac ASB-1** will have a water retention of 44%-48% in the chloride form, while **Ionac ASB-1P** will have a water retention ranging between 51%-58% in the chloride form. **Ionac ASB-2** (Type 2, strong base resin) will have a water retention between 38%-42% moisture.

MICROSCOPIC EXAMINATION: This test, also known as bead count, indicates the percentage of resin beads in a resin sample that are whole, cracked or broken. All beads examined should fall into one of these three categories. It is very important that a representative sample is taken. When the sample is taken from the top of the resin bed, the percentage of cracked or broken beads will normally be much higher than when a core sample is taken. If a large number of broken beads are present in a representative sample, pressure drop or channeling of flow may be experienced by the demineralizer unit. To remove the resin fines see backwash method under "fines removal" in this paper.

ORGANIC FOULING: One of the major foulants of anion resin is naturally occurring organics which can exist in various forms in natural water supplies. The organic fouling test which measures the amount of organic acids (humic and fulvic) found on the anion resin in grams per cubic foot of resin. The following scale shows how reported organic levels relate to the level of fouling. This scale for organic fouling is only applicable to results from Sybron's Field Samples Laboratory.

0 - 2 grams/cu.ft.	**3 - 6 grams/cu.ft.**	**over 6 grams/cu.ft.**
LOW	**MEDIUM**	**HIGH**

This test is conducted on the resin in an "as received" condition. The use of clean up procedures for the removal of organics, listed in this paper, can reduce the level of organic fouling and restore a portion of the lost capacity.

% CONVERSION: This laboratory test is performed to determine the effectiveness of the resin regeneration process. This test is performed on the resin in the "as received" condition. In order for this test to be meaningful, the resin should be regenerated by the customer on site prior to sampling. When the hydroxide conversion is between 60% and 70%, the regeneration procedure being used in the field is considered satisfactory. If the hydroxide conversion is well below 60%, the regeneration procedures being used by the customer should be reviewed.

IONAC® ION EXCHANGE RESINS . . .

SYBRON CHEMICALS INC. is a major U.S. manufacturer of ion exchange resins serving both domestic and international markets.

The following information is a partial listing of the ion exchange products manufactured and marketed by the **Environmental Products Group**. Hopefully, this will more fully acquaint you with the high quality **IONAC** and **IMPACT** products.

Cation Exchange Resins ...

C-267 Strong Acid Gel, 8% Crosslinked, Hydrogen Form

C-249 Strong Acid Gel, 8% Crosslinked, Sodium Form

CS-399 Strong Acid Gel, 10% Crosslinked, Sodium/Hydrogen Form

C-250 Strong Acid Gel, 10% Crosslinked, Sodium Form

CFP-110 Strong Acid Macro, 12% Crosslinked, Hydrogen/Sodium Form

CC Weak Acid Macro, Hydrogen Form

CCP Weak Acid Macro, High Capacity, Highly Crosslinked, Hydrogen Form

Anion Exchange Resins ...

ASB-1 Strong Base,Type 1 Gel, Hydroxide/Chloride Form

ASB-1P Strong Base,Type 1, Porous Gel, Hydroxide/Chloride Form

ASB-2 Strong Base,Type 2 Gel, Hydroxide/Chloride Form

A-641 Strong Base,Type 1 Macro, Hydroxide/Chloride Form

A-642 Strong Base,Type 1 Macro, Hydroxide/Chloride Form

AFP-329 Weak Base, Macro, Free Base Form

Mixed Bed Resins ...

NM-60 Strong Acid/Strong Base Type 1, Gel

NM-65 Strong Acid/Strong Base Type 1, Gel, With Indicator

NM-201 Strong Acid/Strong Base Type 1, Macro

Production and laboratory facilities are located in Birmingham, N.J., with sales offices, warehouses and distribution centers located throught the U.S. and the world. TELE: (609) 893-1100, 1-800-678-0020, FAX: (609) 894-8641

SYBRON CHEMICALS INC.

Birmingham Road
Birmingham, NJ 08011

(800) 678-0020
(609) 893-1100

(609) 894-8641 Fax

www.ionexchange.com